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OVERSIGHT

Office of Oversight
Independent Technical Review of

The West Valley Demonstration Project Event

April 1997

Office of Environment, Safety and Health

TABLE OF CONTENTS

Abbreviations Used in This Report

ALARA	As Low As Reasonably Achievable
ARM	Area Radiation Monitor
CAM	Continuous Air Monitor
CFMT	Concentrator Feed Makeup Tank
DCS	Distributed Control System
DOE	U.S. Department of Energy
HEPA	High Efficiency Particulate Air
HLW	High Level Waste
ORPS	Occurrence Reporting and Processing System
PCM	Personnel Contamination Monitor
RCOS	Radiological Controls Operation Supervisor
RCT	Radiation Control Technician
RSD	Radiation Safety Department
WV	West Valley Area Office
WVNS	West Valley Nuclear Services

OVERSIGHT

Executive Summary

The West Valley Demonstration Project began the vitrification of high level radioactive waste on July 2, 1996. On Saturday, November 16, 1996, the facility experienced a migration of dilute radioactive material into the demineralized-water line outside of the confinement cell. The event occurred during backflushing operations intended to improve the sampling slurry flow rate. As a result of this material outside the cell, high radiation alarms were received in two of the operating aisles and the operating aisles were evacuated. After the event, the Department of Energy (DOE) and West Valley Nuclear Services (WVNS) management both commissioned teams to investigate the event and to propose corrective actions. On January 13, 1997, the DOE Office of Oversight conducted an independent followup review of the event and the corrective actions. The purpose of this review was to ensure that appropriate corrective actions were taken by management and to issue a report that could provide lessons learned to the DOE complex.

This review identified a number of positive attributes associated with event response and subsequent DOE and WVNS corrective actions. Both the DOE and WVNS internal investigations were thorough and timely, and the proposed corrective actions were responsive as well as comprehensive. The 33 corrective actions ranged from additional training and briefings for employees, to design changes to the demineralized-water system. The operations response to the event, given the circumstances and instructions, was appropriate and timely, including the evacuation of the operating aisles and isolation of the source of water to the system. The DOE and WVNS management emphasis on safety was evident throughout this review; evidence of management safety commitment is the comprehensive Westinghouse Operations Manual, which reflects DOE Order 5480.19, Conduct of Operations.

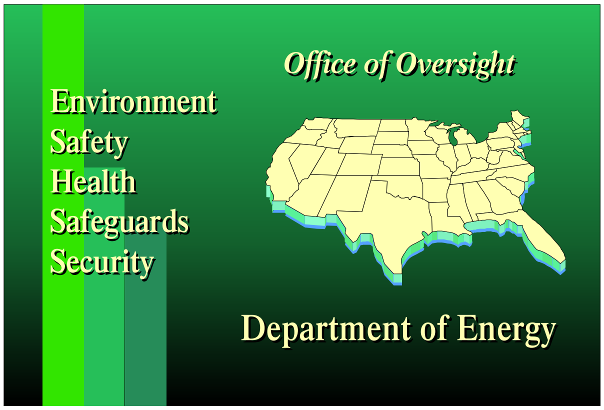
This event, however, raised a number of concerns. The event was potentially more significant from a worker safety standpoint than the demineralized line contact reading of 3.1 R/hour reflected in the occurrence report. This measurement was taken after interim flushing evolutions intended to reduce the radiation levels. Subsequent calculations by WVNS determined that the highest levels experienced outside of the cell were probably about 20 R/hour and could have been twice that, or 40 R/hour, with undiluted slurry. The event could have been much more significant, particularly if a leak had occurred that released material to the operating aisles. Other factors contributing to the significance of this event include a previously unrecognized pathway for radioactive material to exit the cell, the single-barrier function of the three-way valve, and the potential need for both the main and remote operating areas to be evacuated for a single radiological event.

The team also identified concerns associated with management's acceptance of informal operations that are not proceduralized, delay in reporting the event as an unusual occurrence, and inadequate hazards analysis and system configuration control. In addition, the absence of accurate and time-coordinated event data, operator logs, personnel event statements, and timely event critique limited the effectiveness of the DOE, WVNS, and Office of Oversight investigations and root-cause analysis.

The Office of Oversight recognizes that many day-to-day activities at West Valley are accomplished in accordance with approved procedures and structured work control processes. As indicated by this event, however, the plant is still in transition to steady-state operations from a pre-operational and

testing mode, where emphasis is necessarily placed on engineering or expert-based activities. It is important that this transition move quickly to completion to assure more consistent and formal safety management and work controls, including hazards analysis and control, procedure use and compliance, and the involvement of applicable support organizations in work planning, hazards analysis, and work and hazard controls. The Westinghouse Operations Manual, if fully understood, accepted, and implemented, provides an excellent vehicle for this transition and, if followed, could have prevented this occurrence.

1.0 Introduction



The Office of Oversight review follows up on safety management actions in the wake of a November 16, 1996, event at West Valley.

The Office of Oversight conducted a review of the event that occurred on November 16, 1996, at the West Valley Demonstration Project Vitrification Plant. Diluted high level waste slurry was inadvertently flushed out of the shielded cell through a demineralized water line, resulting in high radiation levels and evacuation of portions of the facility. The high level waste was subsequently flushed back into the cell, and with the addition of supplemental shielding, the radiation levels returned to normal.

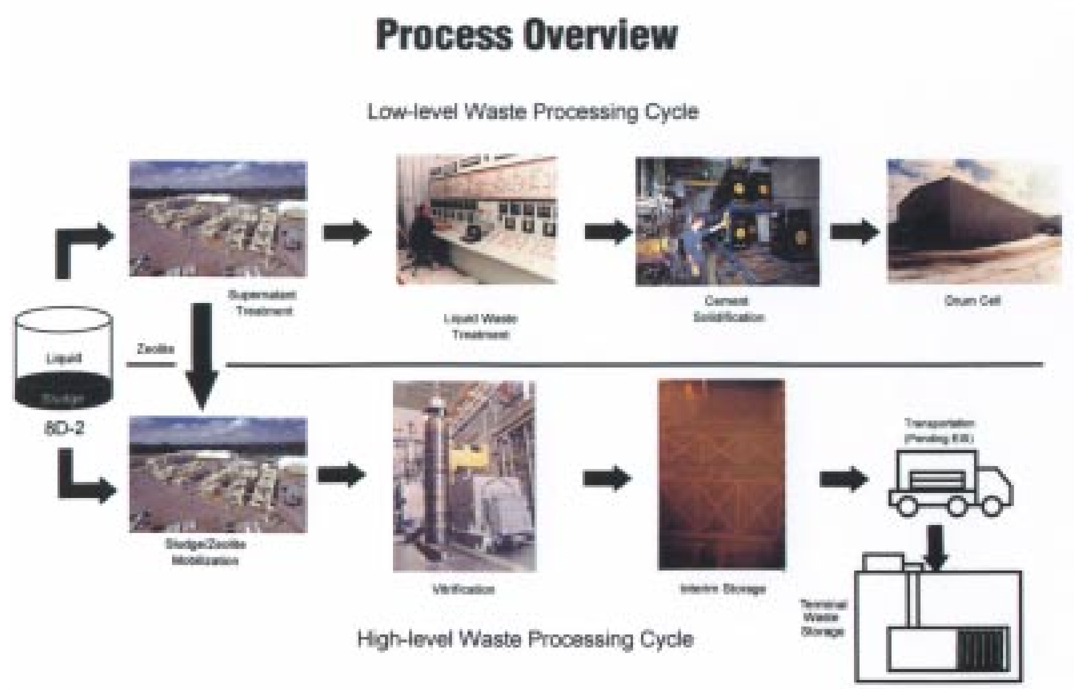
The purpose of this review was to evaluate the safety management processes that involved the circumstances leading to the event, event response and mitigation, root cause analysis conducted by the contractor and the Department of Energy (DOE) West Valley Area Office (WV), and the associated corrective actions and lessons learned. The decision to conduct the independent review was based on concerns over potentially more serious consequences of similar events and the importance of implementing appropriate corrective actions.

The West Valley Demonstration Project is located near Buffalo, New York.

The West Valley Demonstration Project is located 35 miles south of Buffalo, New York. Originally built and operated as a reprocessing plant for commercial nuclear fuel, the site was shut down in 1972, and then turned over to the State of New York in 1976. As a result of reprocessing operations, the site was left with 660,000 gallons of liquid high level radioactive waste stored in underground steel tanks. In 1980, Congress passed the West Valley Demonstration Project Act to demonstrate solidification and preparation of high level radioactive waste for permanent disposal. DOE assumed control of the site under that act in 1982.

The project processes both high and low level wastes in preparation for permanent storage.

The project consists of two primary waste processing cycles. A low level process decontaminated and reduced the volume of liquid in the tanks by removing high activity (primarily cesium)



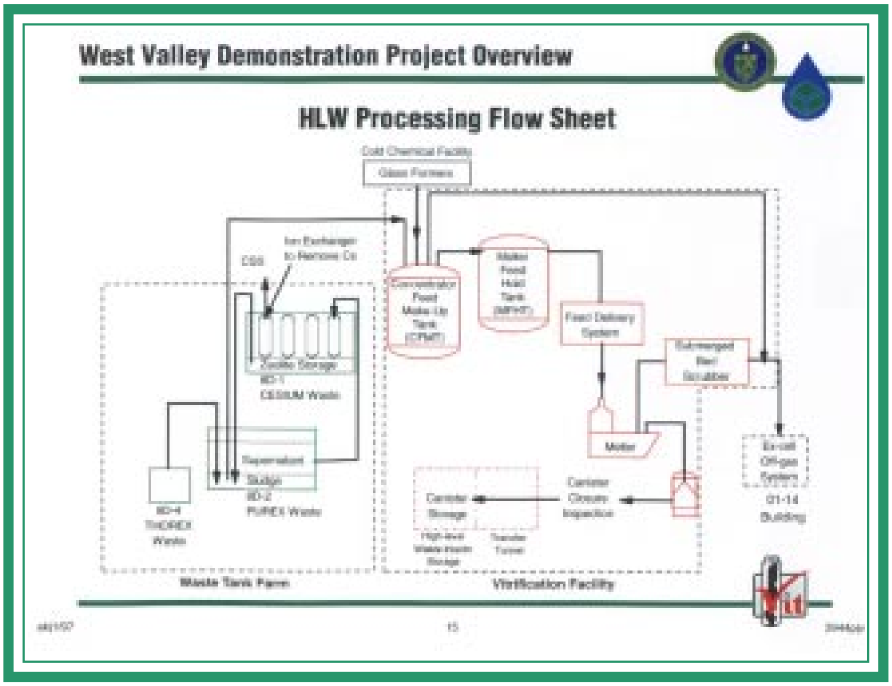
The Two Primary Pathways for Reduction and Stabilization of Waste at West Valley

with zeolite. The resultant low level liquids were solidified in cement. The remaining sludge and zeolite are the subject of the current vitrification campaign. In that process, the high level waste sludge and zeolite are removed from the underground storage tanks, concentrated by boiling, mixed with glass-forming chemicals, and then heated to produce molten glass. The resulting glass is poured into a steel shell and placed in interim storage at West Valley. Eventually, the glass "logs" will be transported to a permanent waste repository.

The vitrification process was successfully demonstrated from 1984 to 1989 with non-radioactive materials. Modifications to the plant were completed and the vitrification plant began processing high level waste on June 24, 1996. As of this review, 67 canisters had been successfully filled. It is expected that approximately 300 canisters will be needed to contain all the waste. Completion of initial vitrification operations is expected sometime in 1998.

The vitrification process begins with a transfer of high level waste from underground storage tanks into a concentrator feed makeup tank (CFMT). There the waste is heated to remove excess liquid, sampled, and treated to adjust the chemistry. Glass formers are then added. To assure that the resulting glass has the necessary durability, these steps are very

A Steel Canister after Being Filled with Glass



Vitrification Process Flow

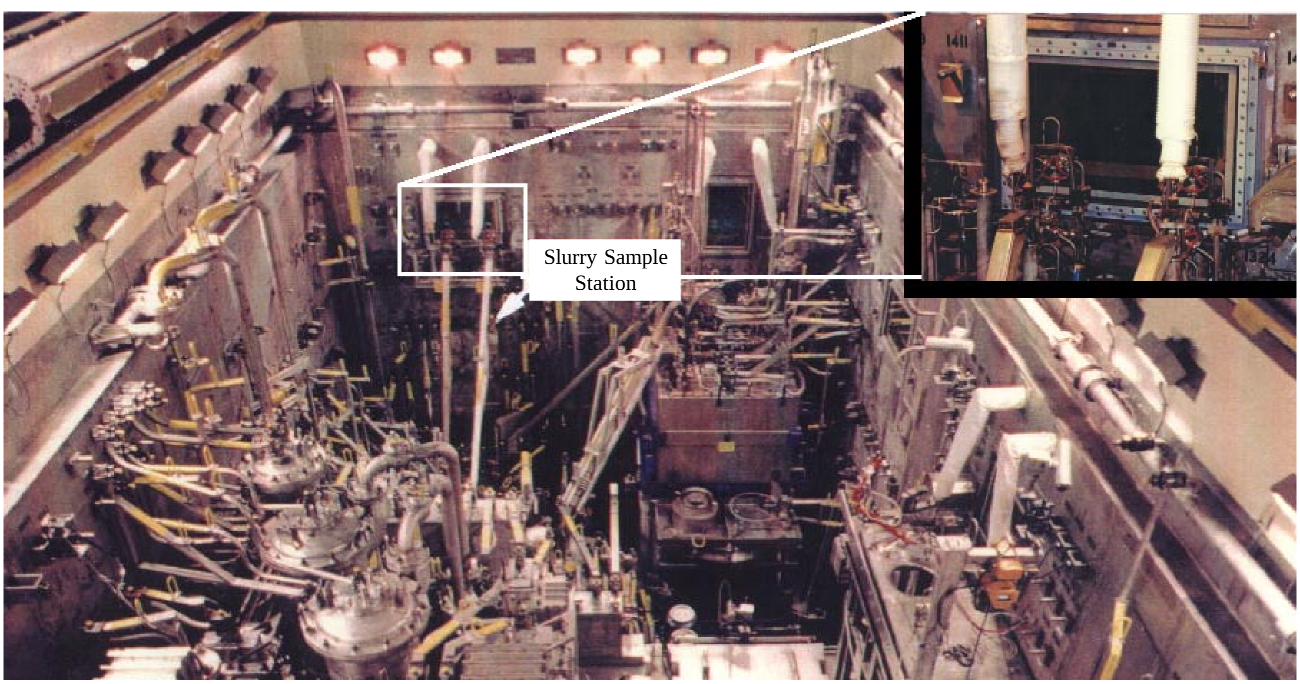
carefully controlled. Samples are tested and recorded. Chemicals are added as necessary, and then additional samples are drawn. Once the material in the tank meets the necessary specifications, it is transferred to the Melter Feed Hold Tank.

The event occurred during the sampling stage, when a small amount of high level waste was flushed out of the tank into unprotected pipes.

On November 16, 1996, sampling operations were under way on the CFMT. During that sampling evolution, the operators experienced difficulty in obtaining the proper samples. While trying to correct the problem, a small amount of high level waste was flushed out of the CFMT into the operating aisles through a demineralized-water pipe. While worker exposures from this event were relatively low, the exposures could have been much higher. Other circumstances surrounding the causes of the event and differences between the contractor and DOE investigations warranted additional review by the Office of Oversight.

The review team consisted of five individuals with extensive experience in integrated safety management, event investigation, root cause analysis, operations, radiation protection, maintenance, and safety analysis. The review consisted of interviews with appropriate personnel, document reviews, and walkdowns of facility equipment and related procedures. The review also included an evaluation of the effectiveness of corrective actions since the event.

A view of the sample station from inside the vitrification cell. The inset shows the manipulators and window where operators draw the samples. The CFMT sampler is on the right.



2.0 Event Sequence

The event occurred on Saturday, November 16, 1996, at approximately 6:20 PM. The Office of Oversight review team developed the following description of events through interviews and use of the root cause analysis reports by the contractor and field office.

On Saturday, November 16, 1996, the flow in the sample line was about one-third the normal rate.

On the afternoon and evening of November 16, operators were sampling the CFMT slurry as part of the vitrification feed preparation. Sampling is conducted remotely in the Middle North Operating Aisle of the Vitrification Facility at the slurry sample station. Other activities in progress included high efficiency particulate air (HEPA) filter testing, and glass pouring to canister WV-172. All other vitrification systems were in normal operating status.

Twenty-four samples are required to ensure that the slurry feed to the melter results in a glass product that is suitable for long term storage. All 24 samples are normally obtained in one to two hours, but on this day it had already taken more than four hours for 16 samples due to problems in filling slurry sample bottles. Available indications led operators to believe the slurry was flowing at approximately one-third the normal rate.

Operators suspected that the sample line was blocked.

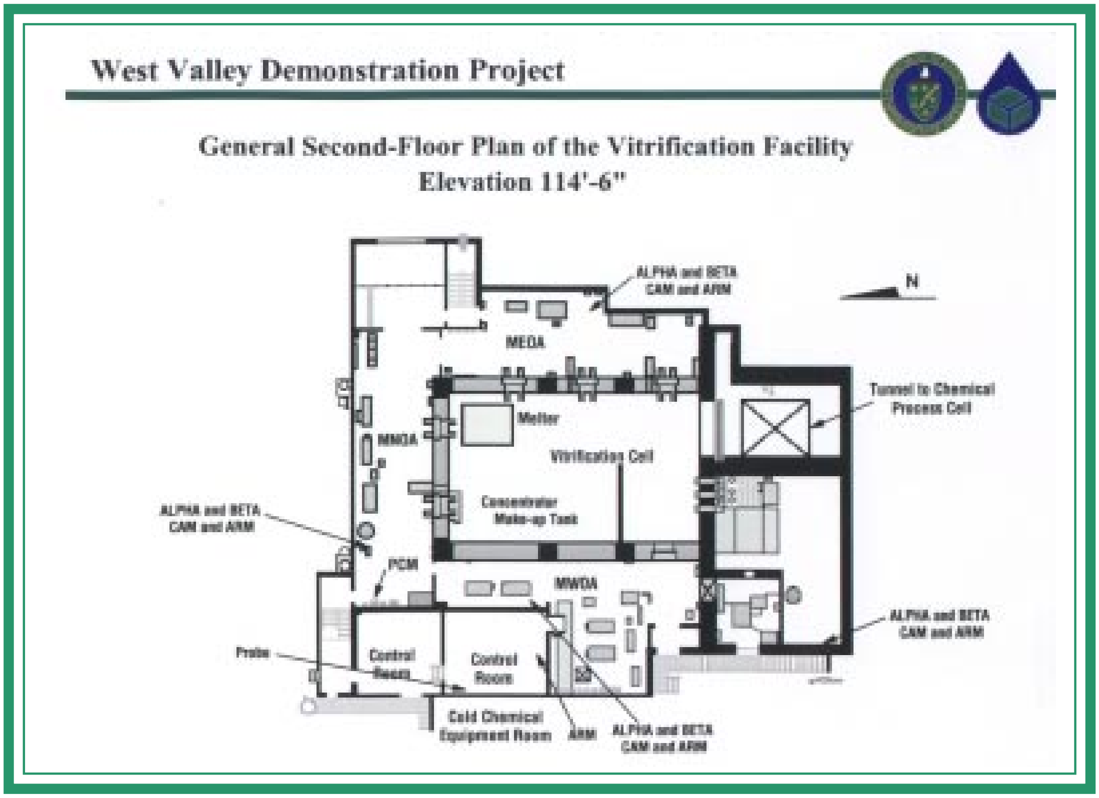
Operators suspected that the sample line was plugged or restricted with slurry. Several attempts were made to flush the sampler, producing a limited improvement in flow. As required by the sampling procedure, operators contacted Engineering for direction on resolving the slow sample flow rate observed that afternoon.

Two engineers determined that the sampling system should be backflushed, and one wrote informal instructions for the backflush before leaving the site.

The cognizant engineer was unavailable, so an engineer knowledgeable in the system was called at home. The knowledgeable engineer reported to the Vitrification Operations Shift Supervisor and began an evaluation of the system. During this time, the knowledgeable engineer was able to contact the cognizant engineer to discuss how to clear the sample lines. The two engineers determined that a backflush should be attempted on the sampling system to improve slurry flow. At approximately 5:45 PM, the knowledgeable engineer provided operators with directions for backflushing the sample line, handwritten on a system drawing. Normal flushing had produced some improvement in sample flow, so operators decided to continue sampling at a reduced flow rate and delayed backflushing. The knowledgeable engineer departed the site at approximately 6:00 PM.

Soon thereafter, the flow stopped and operators began the backflush.

Shortly thereafter, the slurry stopped flowing. Believing the system to be plugged, operators began implementing the handwritten engineering instructions to backflush the sample piping. The sample pump was turned off, initiating an automatic flush sequence for the pump. During this sequence, a three-way valve, HV-0213, automatically cycled to flush clean water through the pump and sample system. This valve should have returned to the vent position 30 seconds after the sample pump was turned off. The sample module and sample vial were



MNOA - Middle North Operating Aisle
MEOA - Middle East Operating Aisle
MWOA - Middle West Operating Aisle

flushed and valves manually positioned to conduct a backflush. A demineralized-water valve was opened to conduct the backflush, with the intention of flushing the piping in the sample lines through the three-way valve and back to the CFMT.

The operator conducting the flush heard a frisker, a personnel contamination monitor, and area radiation alarms after opening the demineralized-water line to begin the flush. This operator reported that upon hearing the alarms, he shut the water supply valve and warned the operator at the sample station to leave the area. One operator attempted to reset the frisker alarm, and the instrument alarmed again. Radiation alarms were received in two of the operating aisles surrounding the vitrification cell and in the control room adjacent to the operating aisles.

Upon receipt of the alarms, the operating aisles were immediately evacuated. At the direction of the operations supervisor, the doors to the operating aisles were subsequently guarded to prevent entry. The radiation monitor in the control room alarmed and reset automatically before personnel in the control room could evacuate.

The area was evacuated. The operations supervisor remained in the control room, where the alarm had stopped and reset.

The operations supervisor decided to remain in the control room to warn others and obtain assistance to determine the cause of the event. Similar instantaneous radiation alarm spikes were also received in the Radiological Control Technician's Office.

Actions following the event included contacting appropriate West Valley management personnel, accounting for personnel, conducting surveys, and performing additional flushes to remove residual slurry remaining in the demineralized-water line.

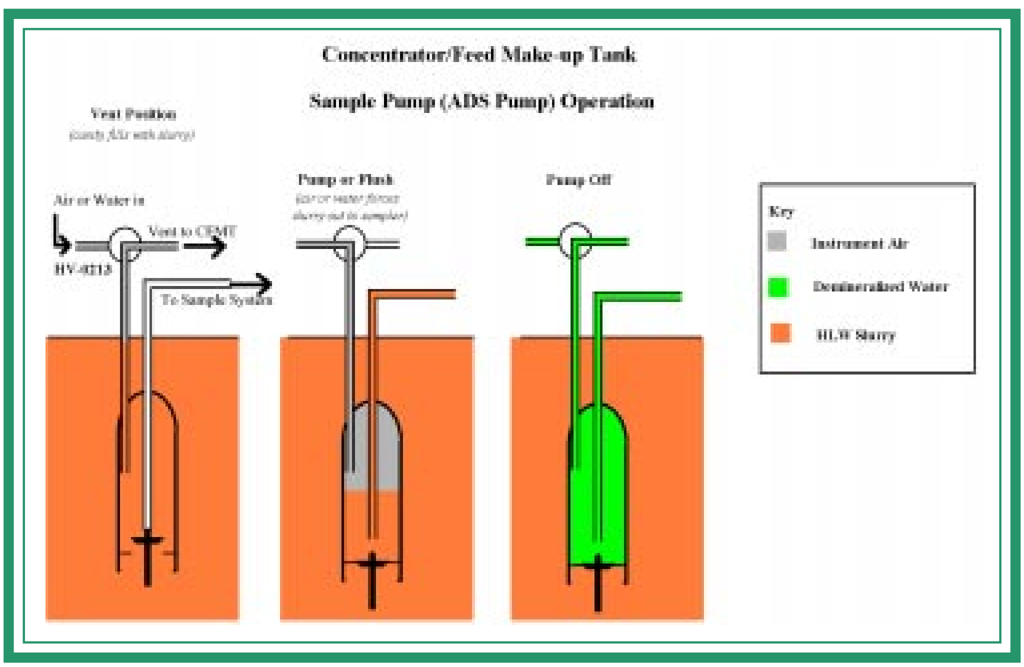
3.0 Analysis

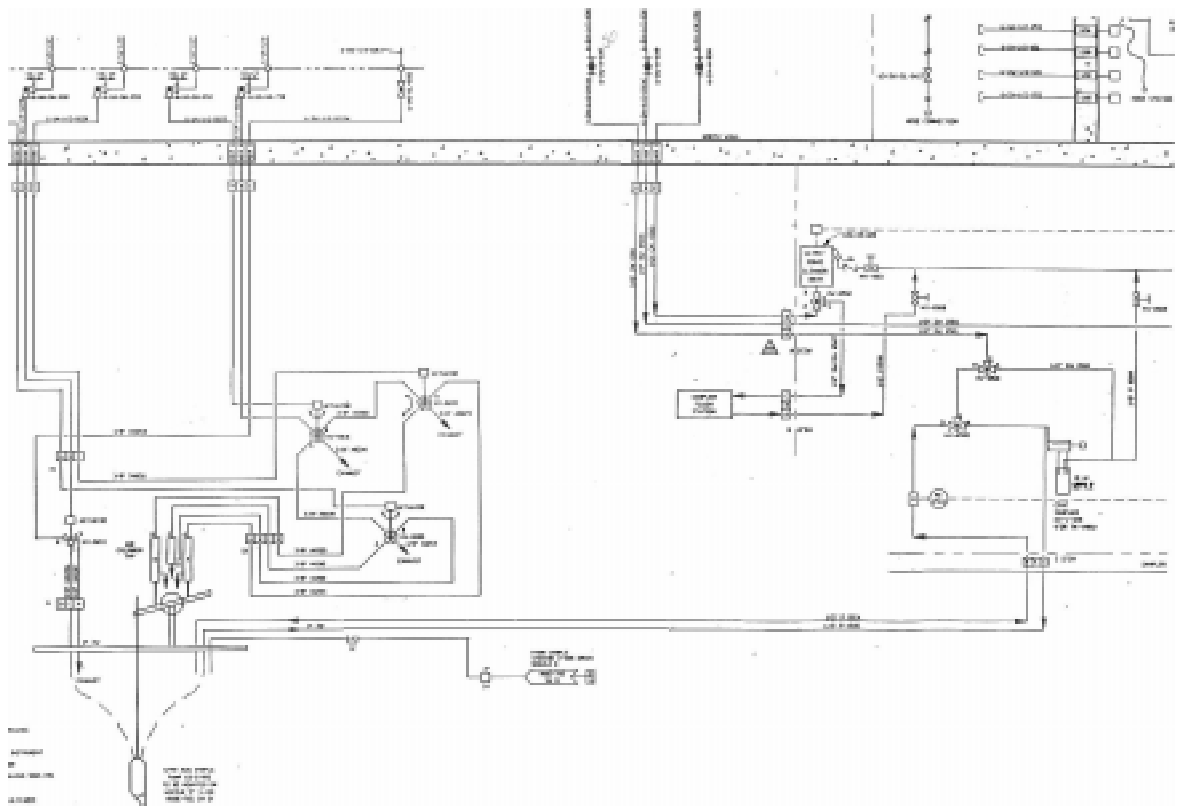
Slurry Sample System Operation

A three-way valve, identified as HV-0213, is a key part of the sampling system.

Slurry sampling from the concentrator feed makeup tank is a routine evolution conducted for each batch prior to transfer to the melter. The CFMT sampling pump (or ADS pump) operates by filling a chamber with slurry, closing the chamber with a poppet, and then using air to force the slurry out of the chamber into the sample system. A simplified diagram is provided above. Valve HV-0213 is normally in the vent-to-CFMT position. When the chamber is opened to the tank, the slurry displaces the air or water in the chamber, filling the chamber.

After a preset time (nominally 20 seconds), HV-0213 rotates to allow instrument air (nominally 35 psig) to push the slurry out of the chamber and into the sample system. HV-0213 and the poppet then cycle in sequence every 20 seconds to provide slurry flow through the sample station back to the tank. When the pump is turned off, HV-0213 allows water to flush the pump and sample system for 30 seconds and then returns to the vent position, leaving the pump filled with water. The sample system consists of piping, valves, and a specialized sample connection that is remotely operated with manipulators. When the sample is drawn, the sample pump produces flow through the sample bottle. The operator then captures the sample by closing the sampler.





Sample System Piping Diagram

Decision to Backflush the Sample System

Backflushing had been used several times to clear blockages in the sample line when normal flushing did not work.

Twenty-four samples are required to ensure that the waste meets the acceptance criteria for long term storage. These samples normally take one to two hours to draw. Plugging or blockage of sample lines due to solidification of slurry is an expected occurrence, and has occurred in the past. Routine flushes normally clear the lines. On several occasions during the cold testing phase, however, normal flushes were not effective. On those occasions, engineers and operators developed an alternative “backflush” method, which had been accomplished six times previously and once since radioactive operations began. It was this backflush method that was being used when the event occurred.

At the time of the event, sampling had taken approximately four hours, and the routine flushes had not significantly improved flow rates. The sampling procedure required operators to contact the cognizant engineer for further direction if difficulties were encountered during sampling. The cognizant engineer was not available that afternoon, and another engineer familiar with the system came in to assist operations in continuing sampling. Both the cognizant system engineer and the engineer who reported to the site later discussed, by phone, options that would flush the sample lines. The cognizant engineer remained at home, while the engineer on site prepared directions for flushing and wrote them on the system drawing.

The engineers believed that the HV-0213 valve provided a sufficient boundary against radioactive materials during backflushing.

The operators and engineers quickly concluded that the slow sample flow indicated plugging of the system; no detailed analysis of the indications was performed to determine alternative explanations. Because the indications were similar to those observed before, the operators and engineers believed that a different flush path would clear the sample lines. The cognizant engineer believed that the automatic valve, as a part of the flush path, provided an adequate boundary for the flush and did not consider other isolation boundaries. The knowledgeable engineer, having access to the drawings, accepted the cognizant engineer's decision to backflush through the automatic valve. The operators then accepted the engineers' decision to backflush.

The operators were frustrated from the difficulty in obtaining samples. Instead of the usual two hours, sampling was into the fourth hour, and shift turnover was approaching. The operators had obtained 21 of 24 samples when the suspected clogging of the sample lines occurred. Normal flushes contained in the system procedure had not solved the sampling problems, and the operator conducting the sampling wanted to complete all 24 samples prior to shift change. At this point, two operators utilized the engineer's handwritten instructions to conduct an abnormal evolution with the concurrence of engineering management. The handwritten instructions contained multiple steps that were carried out by two operators. DOE Order 5480.19 requires procedures to be written in a concise manner in that each step contains one action. Furthermore, the order requires procedures to be written, reviewed, and monitored to ensure that the content is technically accurate and the wording clear and concise.

Neither the engineers nor the site's hazard analyses recognized the potential for radioactive material to exit the cell through the valve.

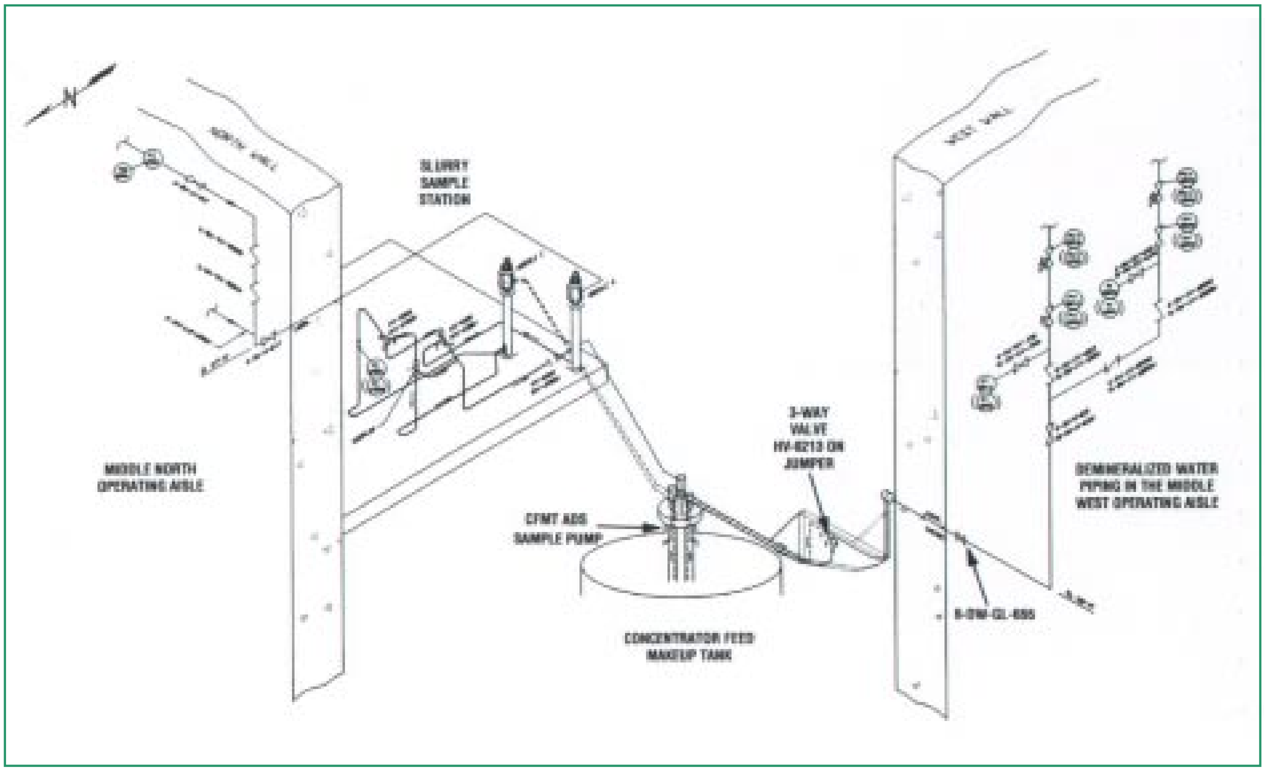
The hazard analyses did not analyze the backflush pathway as a possible means of material getting outside the cell. The knowledgeable engineer was reluctant to backflush through the air-operated ball valve out of concern for getting slurry in the valve but, since the backflush had been previously used, was willing to accept the proposed flow path. The cognizant engineer believed that stopping the ADS pump and subsequent automatic flush would leave the ADS pump full of water with very little, if any, remaining slurry. However, the slurry readily coats surfaces and requires significant flushing to remove. Thus, previous backflushing may have left quantities of slurry on surfaces inside the ADS pump. If the sample lines were already partially or totally plugged, the automatic flush would have been even less effective. Backflushing would then allow slurry to get to HV-0213. The normal operation of HV-0213 minimizes contamination of the valve by ensuring that contaminated fluids always travel away from the valve, and only air is allowed to return through the valve. Knowing the importance of ensuring that the sample pump was flushed normally before backflushing, the engineers still did not recognize the need for a step-by-step procedure. A formal, detailed hazard analysis of the backflush pathway might have highlighted this risk and encouraged the engineers to consider alternative causes and solutions, or at least identify secondary boundaries.

Sample System Backflush Evolution and Event

Neither the onsite engineers nor the shift supervisor observed the backflushing operation.

The engineer on site requested that operators conduct the backflush in her presence to observe the results. Operators delayed the flushing because they continued to obtain samples, although at a reduced flow rate. Shortly after the engineer departed the site, sample flow stopped, and the backflush was conducted. The event occurred during the backflush. The Vitrification Operations Shift Supervisor was involved in the HEPA filter testing and was distracted from the sampling operations, particularly since the engineer arrived to assist in sampling. The Shift Engineer was also involved with other activities and was not paying particular attention to the problems associated with sampling.

The instructions were not formally written or reviewed, and the lineup for the operation was not reviewed.



Simplified Schematic Showing Layout in the Vitrification Cell of the Slurry Sample Piping, the Sample Pump, and the Demineralized Water Piping

The flushing operation was carried out based on instructions that were handwritten on a system drawing. The instructions stated, "After regular flushing with ADS sample pump off, then place both 3 ways in B-C position and flush for 30 sec into CFMT." The lineup for the flushing operation was not reviewed by anyone not immediately involved with the flushing. The Shift Engineer had concerns regarding the status of the sampling pump, but raised them only after the event occurred. Other technical personnel indicated that there was no reason to perform the flush in the manner in which it was conducted.

Radiation monitors recorded spike readings and then leveled off or reset.

Initially, the operators in the control room received a short alarm from the area radiation monitor (ARM) located inside the control room. This monitor had a detector probe mounted on the west wall, opposite the source. At the time, all radiation monitors in the vitrification facility were set to alarm at 0.25 mR/hr above background. Data loggers noted a spike reading of 0.6 mR/hr for the monitor in the control room. Within a few seconds the radiation levels dropped below 0.25 mR/hr (net), the radiation monitor was reset, and the alarm stopped. A radiation monitor located approximately 10 feet across the aisle from the pipe and very close to the outside east wall of the control room had a spike reading of 57 mR/hr and then leveled off, within a few seconds, to 9.5 mR/hr.

The radioactivity content of the liquid being processed was about half the highest possible concentration.

The radioactivity content of the liquid was approximately 7 millicuries per cubic centimeter of Ba-137m. Post-event investigations concluded this was about half the highest possible concentration of radioactivity. Both the initial slug of radioactivity and residual holdup had the effect of raising ambient radiation levels in the control room and operating aisles where another radiation monitor alarmed. In

Demineralized Water Line in the Operating Aisle where Slurry Was Flushed out of the Cell

addition to the radiation monitors alarming, the continuous air monitors (CAMs) positioned next to the radiation monitors and a personnel contamination monitor (PCM) located in the Middle North Operating Aisle automatically detected high background levels and began to alarm. All these radiation monitors, with the exception of the PCM, are linked through a network to a central computerized radiation monitoring system. This system produces audio alarms in both the control room and the radiation safety office in the vitrification facility if alarm set points are exceeded. However, the control room is the only area where operators are continuously present.

At the time the alarms were received, the operators in the operating aisles left the areas and contacted the control room.

The supervisor took effective action to ensure the safety of personnel, but did not follow procedures.

The operations supervisor immediately used the public address system to warn personnel to stay clear of the affected areas. In addition, the supervisor posted individuals at the doors to prevent entry. The control room area radiation alarm reset almost immediately after receiving the initial spike. The operations supervisor did not consider evacuation of the control room, although procedures required it. The supervisor's main concern was mitigating the event and ensuring the safety of personnel. This is particularly evident in the lack of exposure for all personnel involved in the event.

4.0 Event Recovery

Three radiation control technicians responded to the event and took appropriate measurements.

Shortly after the alarms, a radiation control technician (RCT) responded to the event. Initially the RCT had difficulty in finding regular anti-contamination clothing to wear. Expecting airborne radioactivity, the RCT entered Middle North Operating Aisle with a respirator and proceeded to take ambient radiation level measurements and removable contamination smear samples, working into the Middle West Operating Aisle area where the pipe is located. The RCT also pulled the Middle West Operating Aisle air monitor's filter for analysis. Two more RCTs were now assisting with area control, smear and filter counting/analysis, and communication with the control room. It was determined that there was no loose or airborne contamination in any of the operating aisles. However, the RCT was measuring up to 3.1 R/hr at contact (about two inches) from two horizontal sections of the pipe in Middle West Operating Aisle. This caused a 110 mR/hr dose rate in the aisle and a 1 to 2 mR/hr dose rate at the east wall of the control room. At this point the RCTs noted that the dose rates were stabilized. Post-event calculations estimate that the contact dose rate at the pipes may have spiked to 20 R/hr when the slug of material pulsed out of the cell, with corresponding aisle dose rates of 200 to 400 mR/hr. However, this spike dose rate only lasted several seconds. Other than the operators in the control room, there were no personnel in the operating aisles at the time of the event.

Early in the event, a Radiological Controls Operation Supervisor (RCOS) was contacted and discussed the situation with the RCTs over the telephone. The RCOS and RCTs discussed the flush operation being proposed by the operators to reduce the dose rates on the pipe. They agreed to monitor radiation levels as a direct method to determine whether the pipe was being cleared. The RCOS came to the site to assist the RCTs that evening. No one was able to contact the Radiological Control Manager, but the Radiological Engineering Manager was contacted for a telephone consultation.

The pipe holding the backflushed material was flushed and shielded to reduce the contact dose rate.

An ion chamber was placed next to the pipe prior to the flushing operation such that the RCT could read the instrument while remaining in a low dose rate location. The material was eventually flushed back into the cell, reducing the contact dose rate from 3.1 R/hr to between 40 and 50 mR/hr. However, several radiation monitors and air monitors were still alarming from the high area background. It was then decided that lead blankets should be hung over the pipes as temporary shielding. This further reduced the contact dose rate on the pipe to 7 mR/hr. At that point, the RCTs began to document the event and the measurements made during the recovery phase.

Post-event Analysis

Logs and records are inadequate to fully determine the process conditions at the time of the event.

The operators believed that the samples may have been slow because of the high process concentration. The system engineer also considered the high concentration to be a potential cause of slow sample flow, so neither the operators nor the involved engineers considered other causes of slow sample flows. While slow flow could have resulted from process concentration, it is more likely caused by some plugging of the sample piping and was compounded by an imminent failure in the system, possibly sluggish operation of HV-0213 due to slurry in the valve. The event might have been avoided by recognizing the potential for other failures in the system and taking them into consideration when developing the flow path. An alternative explanation, equally credible, is that the pump was actually operating when the demineralized-water backflush was started. Without better logs and records, the actual series of events cannot be determined.

The clocks on the two systems recording the event were not synchronized.

The only reliable records of the event consist of data logging by the Distributed Control System (DCS) and the Radiation Alarm Monitoring System. The DCS records orders by the operators, alarms as they are received, and existing system conditions every three minutes. The Radiation Alarm Monitoring System logs data once per minute. The clocks on the two systems were not synchronized, making correlation of events on the two systems unreliable. After the event, there was an approximately 11 minute difference in the settings of the system clocks. That difference was used by West Valley Nuclear Services (WVNS) to determine whether the ADS pump was off at the time of the event. If that time difference had changed slightly after the event, it is possible that the ADS pump was actually on, indicating a significant error by the operators in coordinating actions to conduct the backflush.

The site's conclusions regarding the event may be inaccurate.

Detailed review of the DCS logs indicate that the ADS pump was turned off at 18:18:57, then turned on 6 seconds later at 18:19:03. No explanation was provided for this action. The pump then ran for 23 seconds and was secured at 18:19:26. WVNS determined that the event occurred after this last action; this conclusion may be inaccurate. The possibility of operator error was not fully discussed in the WVNS report, but was addressed by the corrective actions identified.

Tests on the valve have been inconclusive.

Post-event analysis by WVNS has focused on HV-0213 as the direct cause of this event, but actions to analyze the condition of HV-0213 prior to the event are not conclusive. The operability of HV-0213 was noted to be impaired in tests after the event, but the failures exhibited by the valve would not have produced the symptoms observed by the operators. HV-0213 would not move from the vent position while installed in the system with normal air pressure applied. In this condition, no slurry flow would have been evident during sampling, and backflushes would have directed flush water directly back to the CFMT. When removed from the system, HV-0213 would rotate partially with reduced pressure air. When HV-0213 was tested with normal pressure air, the valve rotated successfully between the pump and vent positions, first exhibiting sluggish behavior, then operating normally. No explanation has been provided for this difference in valve performance in the installed and removed configuration. These results could be consistent with contamination of the valve ball by slurry, which was subsequently loosened with exercise of the valve. Sluggish operation of HV-0213 could explain both the slow sample rates and the backflush pathway, but no firm evidence to support that determination has been provided. WVNS has requested Whitey, the valve manufacturer, to conduct additional tests on the valves under similar conditions.

No hazard analysis is available to support the decision not to perform maintenance on in-cell system components.

Maintenance is not performed on sample system components inside the vitrification cell. No facilities were included in the original design to allow removal, disassembly, or repair of contaminated components. Plans are currently in place to install a maintenance area within the cell that would permit such actions. In the interim, many components of the vitrification plant, such as jumper assemblies, are "run to fail." No detailed hazard analysis to support this decision was available.

Procedures and procedural adherence are causes for concern.

Of concern during the WVNS and DOE post-event reviews were the procedures in place for responding to the event and adherence to these procedures. West Valley Demonstration Project emergency procedures are such that an alert or site emergency would be called if there is a potential for release of material and offsite exposure to the public. However, this event did not involve release of material from the pipe, and once the situation was characterized, it only presented a high external radiation field hazard to employees. Radiation Safety Department (RSD) procedure RC-ADM-32 addresses response to loss of radioactive material, but focuses on lost sealed sources or spills of radioactive materials. Response to a high radiation field scenario is not specifically addressed. Nevertheless, control room operator procedures (SOP 63-81, Rev. 1, pg. 464) require the evacuation of the control room if a radiation monitor alarms. However, because the control room radiation monitor reset after the event in question and the dose rates in the control room were measured below 10 mR/hr, it was determined that the best course of action would be to try to flush the material back into the cell. During the event, none of the RCTs had extremity dosimeters, and the two telescoping survey instruments on site were locked in the instrument calibration shop and not available for use.

The event was not reported in a timely manner.

Associated with the issues involved with responding to the event, concerns were also identified in the timeliness of WVNS in notifying DOE and reporting the event in the Occurrence Reporting and Processing System (ORPS). The event was not classified for two days and not reported in ORPS for four days. WVNS cited the inability to interview operators and the need for engineering analysis as the reasons for the delay. However, analyzing events before reporting defeats the intent of the order for rapid dissemination of operating experience. A review of other occurrences over the last year indicates that 15 of 25 events were not entered into ORPS in a timely manner.

The facility safety analysis report identifies operational hazards and the mitigative features and programs in place.

The safety analysis report (WVNS-SAR-003, Rev. 4) for the vitrification facility identifies the hazards associated with vitrification operations as well as the design features and programs in place to ensure that workers and the public are adequately protected. Radiation protection requirements are those of 10 CFR 835, site-specific Radiation Protection Program; DOE Radiological Control Manual (DOE/EH-0256T) and respective site manual; DOE Order 5400.5, Radiation Protection of the Public and the Environment; and other applicable regulations, orders, and standards. Several items in the safety analysis report are relevant to this event. Specifically, a number of as-low-as-reasonably-achievable (ALARA) design considerations were incorporated in the vitrification facility to reduce radiation exposures. Included were remote-indicating radiological instrumentation for operators to monitor product and process conditions. For any full-time occupancy areas, the shielded cell was designed for a maximum dose rate of 0.25 mR/hr. Higher dose rates were allowed for lower-occupancy areas (e.g., operating aisles). Nonetheless, a defense-in-depth design of the vitrification facility was put in place to assure facility safety during normal, off-normal, and accident conditions. The primary layers of this defense are: passive confinement barriers, waste form and limited inventory, active confinement barriers, alarms and monitors, personnel training, and administrative planning and controls.

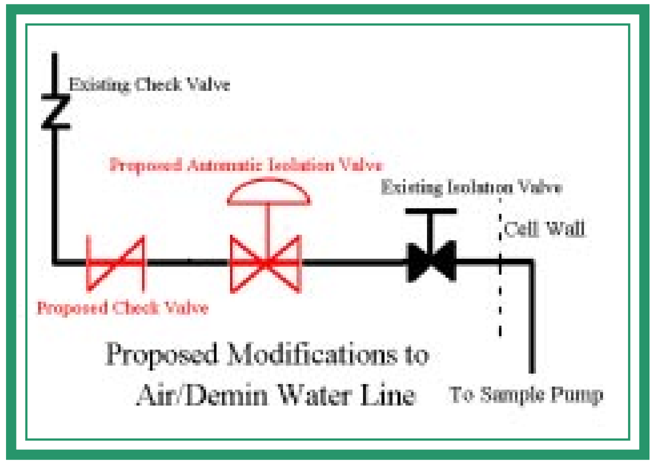
There was no technical basis for the initial placement of the radiation detector probe in the control room.

The safety analysis report notes that radiation monitors and air monitors are placed at strategic locations throughout the vitrification facility to warn operators of elevated radiation and contamination levels. There is no technical basis document for locating the radiation monitors or determining alarm settings for various vitrification facility areas. At the time of the event, all radiation monitors were set to alarm at 0.25 mR/hr above background. The settings have since been changed by the RSD to have a high alarm at 0.25 mR/hr, and a high-high alarm at 10 mR/hr in the control room and 1 or 5 mR/hr in other vitrification facility areas. However, there has been no analysis of what the lowest possible undetected dose rate might be along an operating aisle, given these settings and radiation monitor locations. There is only a single radiation monitor positioned in each aisle, which can be about 30 feet from a potential source. The lack of a technical basis may have been a factor regarding the initial placement of the radiation detector probe in the control room on the wall furthest from the cell. The issue of the radiation monitors having a range of 0 to 200 mR/hr and the potential need for passive thermoluminescent dosimeter monitors in operating aisles for dose reconstruction during off-normal or accident conditions has not been examined.

WVNS Corrective Actions

The contractor has implemented a number of corrective actions.

As a result of their investigation, WVNS identified a number of corrective actions. The jumper containing the failed valve was replaced. The sampling procedure was revised to incorporate specific instructions for alternative flushing methods. The backflush method used in this event was specifically excluded from the procedure and will not be used in the future. A review team was established to assess weaknesses in other standard operating procedures. Modifications to the demineralized-water line isolations were identified, including moving the check valve closer to the cell wall, installing an automatic isolation valve, and modifying the existing isolation valve design to provide better leak protection around the valve stem. Other in-cell components and systems were evaluated for possible exit pathways and the need for additional isolation. Briefings were conducted with all shift operating crews and engineers on these changes before resuming vitrification operations.



Relevant procedures have been updated, but some are not explicit.

Standard operating procedures for control room operators should have prompted the operators to immediately evacuate the control room. These procedures have been updated to allow for control room occupancy at higher radiation levels (i.e., 10 mR/hr); however, the actions the operators and RSD staff should take during software or power failures and high or high-high alarms are not very explicit. For example, a Category 1 high gamma area alarm notes that the operator action should be: "If feasible, secure melter feed, airlifts, all transfers, boildowns and evolutions in progress."

5.0 Conclusions

Strengths and Positive Observations

A number of strengths were noted.

The independent oversight event review indicated a number of strengths or positive observations associated with this event:

- Both the DOE Project Office and WVNS initiated team investigations of the event to identify lessons learned and corrective actions. These internal investigations were both thorough and timely and included numerous interviews, analysis of data and information, and walkdowns of the event and related equipment. The results of both investigations were documented in written reports.

- The corrective actions identified by DOE and WVNS as a result of these two internal investigations were both comprehensive and responsive to the issues identified. Thirty-three corrective actions were identified covering forty-one individual items. These corrective actions ranged from additional employee training to significant design changes to the demineralized-water line. These corrective actions and the responses were documented in a WVNS Corrective Action Request for Significant Issue dated January 10, 1997.

- The operations response to this event was both timely and appropriate given the difficult circumstances and indications, including high radiation alarms in both the main control room and remote control areas, ongoing HEPA filter testing, and the event occurring at shift change. The Vitrification Operations Shift Supervisor and operators initiated prompt actions to:

  - Evacuate the operating aisles
  - Isolate the source of water (valve 647)
  - Stabilize the plant
  - Flush the demineralized line to reduce radiation leak.

- The Westinghouse Operations Manual in use at West Valley reflects DOE Order 5480.19, Conduct of Operations, and provides comprehensive guidance for safe plant operations. Guidance is provided for key areas of safety management, such as work planning and control, procedure use and compliance, communications, system configuration control, shift supervisor authority, and the direction to stop work when unexpected conditions are encountered.

Interviews and document reviews conducted during this followup review indicate strong management support for safety, beginning with the DOE Project Manager and running down through both the DOE and WVNS organizations. It is this strong emphasis on safety that makes this particular event appear to be a carryover from the less formal startup and testing activities, rather than reflective of the normal approach to West Valley operations.

Concerns

Several concerns were noted.

A number of concerns were identified by the followup review, most of which were also identified during the DOE and WVNS investigations:

- This event is considered significant due to the potential impact on worker safety and facility mission and the lessons learned for the facility, other vitrification facilities, and the DOE complex in general. Several factors contribute to this significance:

  - This represents an unexpected flowpath for highly radioactive material outside of the cell into a potentially occupied area.
  - The importance of the three-way valve (HV-0213) as a single barrier to a release of radioactive material outside the cell had not been identified.
  - The contact radiation levels at the demineralized-water line outside the cell were probably much higher than the 3.1 R/hr reflected in the occurrence report. WVNS calculations indicate that the peak level may have been closer to 20 R/hr and could have been over 40 R/hr under different conditions.
  - This event, which caused high radiation alarms in both the control room and the operating aisles, had the potential to require simultaneous evacuation of both the main control room and the remote control area due to a single event or equipment failure.

- The Office of Oversight is concerned with management's and operators' acceptance of an informal approach to the conduct of a plant evolution, however infrequent. This same method of backflushing, including the lack of approved procedures or formal hazard analysis, had been conducted and accepted several times in the past during both cold and hot operations. This reliance on expert or engineering-based guidance has apparently carried over from the startup period, when approved system operating procedures referenced contacting the cognizant engineer for direction. These procedure references have since been deleted as part of the event corrective actions.

- The delay in classifying and reporting this event to DOE as an unusual occurrence is a concern. The event occurred on Saturday, November 16, 1996, but was not classified until two days later and was not reported on ORPS until Wednesday, November 20, or four days later. Line management provided a number of reasons for these delays:

  - The event occurred on a weekend.
  - The potential significance of the event was not clearly communicated to management.
  - There was difficulty in aligning the event with the criteria provided in the DOE order.
  - Additional time was needed to interview the operators involved and to analyze the event.

The site indicated concern about the use of the occurrence reporting system.

In addition, there appears to be sensitivity to potential overreporting and the potential reaction of DOE Headquarters. There was a feeling expressed that the original intent of the ORPS system—to quickly and openly share events and lessons learned within the complex—has been replaced by number-counting and "beating up" those who openly report. One positive aspect of reporting was that the DOE and WVNS managers interviewed expressed a consensus that the event was reportable and should have been reported on Saturday.

6.0 Opportunities for Improvement

Although the DOE and WVNS internal investigations and Corrective Action Request for Significant Issue identified 33 corrective actions, the Oversight event review identified additional opportunities for improvement in safety management at West Valley.

1. Strengthen event classification and reporting.

Basis: For a number of reasons, this event was not classified as an unusual event for two days and was not reported in ORPS for four days.

Opportunities for Improvement:

- Assess and correct barriers to timely reporting, including occurrences on weekends and sensitivity to overreporting.
- Focus on the timely sharing of events and lessons learned within the DOE complex, and avoid excessive focus on alignment of events with the specific reporting criteria in the DOE order.
- Improve the communication of the actual or potential significance of events to management, particularly on weekends and backshifts.
- Provide additional training to managers, supervisors, and staff on the importance of timely classification and reporting.
- Consider use of a multi-disciplined panel, with representatives from various organizations (including operations, engineering, radiation protection, and industrial safety), to determine reportability.

2. Strengthen event critiques and reporting.

Basis: The ability of the DOE, WVNS, or Headquarters event investigation teams to reconstruct this event was negatively impacted by a delay of several days in conducting a full critique and the failure to obtain individual written statements from those involved in the event.

Opportunities for Improvement: Strengthen event critiques and records in accordance with DOE Order 5480.19 and the Westinghouse Operations Manual:

- Conduct critique meetings as soon as the plant is stabilized and before the individuals involved leave for the day.
- Obtain individual written statements from people involved in the event before the critique and cross conversations.
- Consider conducting walkthroughs of the event with individuals in small groups, focusing on what was seen and heard as well as specific actions or problems encountered.

3. Commit to a strong conduct of operations program.

Basis: This event involved a disturbing acceptance of an informal approach to the conduct of plant evolutions and an overreliance on expert or engineering-based guidance that appears to be a carryover from the plant startup period.

Opportunities for Improvement: Continue to strengthen conduct of operations in accordance with DOE Order 5480.19 and the Westinghouse Operations Manual:

- Improve control of system and equipment alignments, including Vitrification Operations Shift Supervisor written authorization, logging, and independent verification where applicable.
- Require real-time documentation in operator logs of significant operations, system

alignments, problems, alarms, and corrective actions.
- Require use of and adherence to approved procedures, including stopping activities when procedures do not work.
- Improve communication and coordination of activities involving operators in the control room and in the field, including procedure use and signoffs.
- Improve control over troubleshooting activities by requiring Vitrification Operations Shift Supervisor review and approval, use of approved work instructions or procedures, and documentation of actions or system alignment changes.
- Conduct effective and timely pre-job briefings that include discussion of hazards and precautions and participation by all organizations and individuals involved.
- Improve understanding and implementation of the Westinghouse Operations Manual through training, management coaching, and accountability.
- Implement the 30 to 35 percent time in the field for managers and supervisors, as indicated in the Westinghouse Operations Manual, training, coaching, and correcting (at least until conduct of operations is fully accepted and implemented at WVNS).

4. Strengthen procedure quality and use.

Basis: The acceptance and use of procedures at WVNS appears to be negatively impacted by several factors, including a lack of confidence in procedure quality, overuse of procedure field changes, and the attachment of historical procedure revisions (14 pages in one instance) to procedures in use.

Opportunities for Improvement: Improve procedure quality and encourage use and compliance in accordance with DOE Order 5480.19 and the Westinghouse Operations Manual:

- Strengthen the field validation process associated with new or revised procedures to improve usability and reduce the number of subsequent field changes.
- Stabilize procedures by limiting field changes to those necessary to successfully accomplish the procedure; reserve administrative and grammatical changes for the normal revision process.
- Attach only the most recent procedure field changes to procedures in use; maintain historical changes on file.
- Do not integrate field change page numbers into procedure page numbers.
- Improve quality control over procedure field changes, including review and approval.
- Increase accountability for procedure use and adherence in conducting plant activities and evaluations.